Stochastic modelling techniques meet practical needs

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Stochastic modelling and analysis is a well-established discipline which focuses on the evaluation of quantitative measures of systems, such as performance, dependability, or energy consumption. A wide range of sophisticated modelling methods and analysis algorithms has been developed in this area, many of which have been implemented in available software tools. Even though these methods and tools are extremely powerful, they often reach their limits when facing the needs of real-world systems, due to the following reason: Scalable parallel or distributed systems with a high degree of concurrency lead to models with extremely large state spaces, which renders most state-space-based analysis techniques intractable.

Among the techniques addressing this problem, the so-called "symbolic" approach, which relies on the use of decision diagrams as its basic data structure, has shown to be very effective. Starting from a formal model specification (expressed, for example, in the language of queueing networks, stochastic Petri nets or stochastic process algebra), a compact symbolic representation of the underlying labelled Markov chain is generated automatically. All subsequent steps of analysis can be performed in an efficient manner based on this representation. This includes preprocessing steps, such as reachability analysis and the elimination of vanishing states, but also different forms of numerical analysis and the computation of the measures of interest. Iterative methods for calculating the vector of steady-state or transient probabilities can be realised efficiently, while being much more space-efficient than solutions relying, on sparse representations. The key to success with this symbolic approach lies in the proper exploitation of the system's compositional structure, which is reflected in the structure of the decision diagram, leading to its compactness and efficiency of manipulation.